POLYPHEMUS PEDICULUS (L) (CLADOCERA) AS A POSSIBLE INDICATOR OF WATER QUALITY

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Usually stenobiotic species are used as hydrobiological indicators of the degree of pollution in natural waters (Makrushin, 1976).

Cladocera are eurybiotic organisms, therefore their role as specific indicators of the water quality is considered to be insignificant (Bening, 1941; Makrushin, 1976).

If, however, we approach the evaluation of waters from the point of view of the method of Zelinka and Marvan (Zelinka M, Marvan P, 1961) which is based on the occurrence frequency of each of the detected species in various saprobic zones, the importance of Cladocera as the most numerous and widely spread species in the specification of waters greatly increases. On the basis of this method Cladocera at present are more and more often used as indicators of oligo- and mesosaprobic waters as well as of the presence of considerable amounts of easily degradable organic matter (Makrushin, 1976). Work over many years on the biology of *Polyphemus pediculus,* this striking representative of the order Cladocera, convinced us of the possibility of using this species not only as an indicator of water purity but also for the estimation of the degree of water pollution as well as of water characteristics such as colour, turbidity, oxgen content and chemical composition.

P. pediculus is one of the most common and abundant species of planktonic crustaceans in shallow waters of reservoirs, rivers, lakes, ponds and temporary water bodies. It belongs to the group of arctic or subarctic species (Butorina, 1971).

It is a littoral stenothermic species with circumpolar distribution (Haberbosch, 1920). It is numerous in water bodies of northern countries (Berg, 1948; Pesta 1954). Southwards, its abundance and the extent of its distribution diminish (Rammer, 1930). The most southern place where it occurs is the North Sicilian Lakes (Parenzan, 1932). *P. pediculus* is found in the plankton of a water body in small aggregations. They have a mushroom-shaped spatial configuration with a greater or lesser concentration of crustaceans in the upper 5-10 cm layer of water. The aggregations are spread over the water surface as patches of round or oval shape. The size of the patches, their shape and number per square metre, the distance between them and number of organisms in them vary, depending on the season and type of the water body.

Having appeared early in spring, the crustaceans do not disappear from the plankton till late autumn in all the waters of the middle zone of the northern hemisphere. The location of their aggregations in a water body is strictly permanent during not one day but the whole vegetation season.

The polyphemid differs from other Cladocera in that it has a naked body not covered by a carapace, 0.2-1.0 mm in size, a huge compound eye occupying the whole of the animal's head and a number of special sensory organs located on the head and on the legs of the crustacean. As a result of this, the crustacean is notable for its peculiar sensitivity to all environmental factors.

The polyphemid possesses an inherited grouping effect. It is manifested in a reduction in energy expenditure for locomotion and respiration in the collective coexistance of the individuals; while the intensity of feeding, fecundity and longevity of each crustacean in an aggregation increases sharply. Therefore, it is only under conditions of collective existence that the optimum conditions are created for the maximum living functions of each organism. The aggregations of crustaceans possess also a swarming effect, which is manifested in coordination of the efforts of individuals when in danger or catching food. Thus, the mushroom-shaped aggregations of the polyphemids may be classified as normal pelagic swarms without dominance (Rudakov, 1972).

The method of existing in swarms in the polyphemid has been the result of evolution. This is an ecological phenomenon which ensures a unity of the organisms with the environment. The swarms are necessary for the polyphemid primarily for satisfying its food requirements and the continuation of the species. Only by hunting as a group can they catch the necessary amount of prey, and only by being within a tight swarm can the males find the gamogenetic females and the latter produce latent eggs from which parthenogenetic females emerge again in spring. In natural water-bodies the crustaceans exist only in swarms. The swarms are formed only through the interaction of 3 main factors: the presence of a definite chemical background produced by exometabolites of the crustaceans, certain visual signals and ultrasonic oscillations appearing as a result of the movements of the locomotory antennae of the individuals of their own species. Any changes in ecological conditions disturbing the equilibrium of these interacting factors lead to a reduction in the swarming and grouping effects of the individuals. This causes a weakening of the ties between the crustaceans within a swarm and finally leads to its disintegration followed by the death of the crustaceans. The first sympton of disturbances in the normal existance of the swarms as single wholes is an increase in the respiration intensity of separate individuals. The polyphemids usually respond to all the deviations in the aquatic medium from the normal conditions by a sharp change in respiration rate. This test is very indicative, easily detectable and may be used as one of the main signs of deterioration in the ecological conditions of a water-body.

All the cladocerans have a single complex compound eye. Its structure allows the crustaceans to discern the length and intensity of the light wave (Smith, 1953; Scheffer et al, 1958; McNaught, 1971; Hihdley 1975) as well as the degree of its polarization (Verhovskaya 1940; Smith & Baulor 1953). Cladocera are able to recognise visually other animals, to select food actively (Butorina, 1972), to choose biotopes (Barry, 1974) and to avoid en emies (Butorina 1969, 1972; Barry 1974).

Due to the presence of the huge eye the polyphemid quickly notices and reacts to all changes in the biotope; to the degree of its illumination and water colour. As a consequence of its special visual capabilities, the crustacean avoids brightly illuminated sandy water bodies lacking shady places. The crustaceans die at a light intensity of 4000-4500 lx in the water if they cannot migrate from the danger zone (Butorina 1969).

The young polyphemids gather into swarms at an illumination of 315-1080 lx. They prefer ultraviolet rays, as well as all the shades of blue, green and yellow. Adult individuals gather into swarms in the near-bottom layers of water at an illumination of 47-1035 lx in all the shades of yellow, blue and violet. Near the surface the adults aggregate at 105-1215 lx in all shades and mixtures of light-yellow, green blue and light-grey light. All individuals of *P. pediculus* avoid any shades of red, purple, brown, dark blue, dark green and dark grey colours (Butorina, 1976). Due to this, the crustaceans die in turbid, intensely coloured and "blooming" waters.

Under such conditions there take place disturbances not only in visual communication but also in the ultrasonic one. In the presence of great amounts of suspended matter, blue-green algal and diatoms the conditions for transmission of the ultrasonic waves apparently change. As a result the polyphemid swarms disintegrate and the individuals die.

Since the polyphemid is of northern origin, it prefers waters with the optimum temperatures of 17-21°C (Butorina 1971). At the higher temperatures the growth rate and fecundity rapidly diminish. In the surface layers of water mortality begins already at 25°C. If such a temperature continues for several days and the whole water becomes warm the polyphemids disappear completely from the plankton. As a consequence of these physiological peculiarities, the crustaceans cannot live in heated waters or in cooling basins in which usually the temperature is lethal for them. We have established that all the polyphemids possess great locomotory activity. Active metabolism comprises from 30 to 80% their total metabolism and, as a result, the crustaceans attaining great numbers in waters need large amounts of oxygen and live only in waters with a normal oxygen regime. With a *decrease* in oxygen content due to environmental pollution or any other cause the polyphemids, especially the most sensitive such as newly born ones or gamogenetic females, disappear from the plankton first. Thus the presence of great numbers of *P. pediculus* in a water-body may serve as a good indicator of its good oxygen conditions.

In the case of the entry into the water of pesticides such as Strabon (polychlorpinen) or similar substances the polyphemid, thanks to its morphological and physiological peculiarities, responds to their presence in any concentration faster and more distinctly than other Cladocera.

A low content of Strabon causes inconstant and inconsistent changes in the respiration intensity of the polyphemid. In more sensitive individuals, such as gamogenetic females, with a prolong action (7-10 days) of low concentrations of Strabon on the swarms, a gradual and stable increase in respiration rate of the individuals occurs leading to disintegration of the swarm and death of the crustaceans. Females disappear from the plankton by the 10-14th day of the experiment. It follows that at a low concentration of Strabon only some shortening of the life cycle of chemically sensitive individuals takes place. The rest of the polyphemids are less sensitive to low concentrations of Strabon. Within the first week of the experiment they are capable of adapting to them, recovering their respiration and consequently the life function of the swarm in its unity with the environment to the normal level.

Higher concentrations of Strabon cause sharp and momentary increases in respiration in all polyphemids. These changes are so significant and irreversible that they lead to disturbance in all the factors of the normal existence of the crustaceans. The chemical channel of communication between individuals changes and the grouping effect completely disappears. The swarms disintegrate, the crustaceans sharply increase the velocity and character of movement and virtually do not feed. Such changes usually lead to a rapid death of all the individuals of the species.

Thus, the comprehensive investigations of the morphology and biology of *Polyphemus pediculus*, its distribution, the dynamics of its abundance, and intensity of respiration under various environmental conditions have shown that the crustacean in a number of its characteristics, such as changes in abundance, sex ratio, fecundity, growth and respiration rate, may serve as a hydrobiological indicator of the quality of natural waters. Its presence in masses in a water-body is indicative of the purity and clarity of a water, of a normal oxygen and thermal regime, as well as of a natural chemical composition of the waters characteristic of the water bodies of the middle zone of the northern hemisphere.

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